# Space Weather Technical Forecast

Issued on Wednesday, 05 October 2022 at 13:14 Local

**This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales**

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**Space Weather Forecast Headline: G1/Minor storms possible throughout. Ongoing likelihood of M-class flares with slight chance of isolated X-class flares due to AR3110 and AR3112.**

**Analysis of Space Weather Activity over past 24 hours**

**Solar Activity:** Solar activity has been Moderate with one M-class flare observed from the region of AR3110 in the northwest quadrant at 04/0805UTC, which has also produced a number of C-class flares. AR3112 is the largest region, but has also produced some C-class flares. There are four other sunspots regions the visible disc, three of which are relatively benign beta regions, and these appear to be stable, and one alpha region. Two CMEs on the 4th October have been analysed, one from the northwest and the second from the southeast. These are forecast to arrive at Earth either late on day 2 (6th Oct) or early on day 3 (7th Oct), although these are low confidence. Meanwhile, a filament eruption, which lifted off the southwest quadrant early on the 5th Oct, produced another CME, which is currently under analysis for any potential Earth-directed component.

**Solar Wind / Geomagnetic Activity:** Solar wind speeds as observed by DSCOVR at L1, have averaged between 500-600km/s under the influence of a solar wind high speed stream. Density has been steady at slightly above average levels. Total magnetic field strength started around Moderate levels, but has declined to weak by the end of the period. The north-south component, Bz, has varied weakly between positive and negative levels, but has been predominately negative since 04/1700UTC. The phi angle has been mainly positive (away from the Sun). Resultant geomagnetic activity was mainly Quiet to Unsettled (Kp 0-3), but with one G1/Minor Storm (Kp 5) interval between 04/1800-2100UTC.

**Energetic Particles / Solar Radiation:** The high energy proton flux (greater than 10 MeV) as measured at GOES16, has been close to background levels. High energy electron flux (greater than 2 MeV) varied between background to moderate levels. The associated 24-hour fluence remained well below the Active (1e8 integrated pfu) threshold, but on a slightly rising trend. Observed fluence at 05/0001 UTC was 8.9e6 integrated pfu.

**Four-Day Space Weather Forecast Summary**

**Solar Activity:** Solar activity is forecast to be Moderate, with a chance of High levels, due to likely further M-flares or perhaps X-flares possible from AR3110 and AR3112.

**Solar Wind / Geomagnetic Activity:** There is a risk of CME arriving at Earth either late on day 2 (6th Oct) or during day 3 (7th Oct). The current coronal hole high speed stream is expected to subside to background through the next few days in the absence of CME effects. A further coronal hole high speed stream is then forecast to connect with the Earth on day 4 (8th Oct). Geomagnetic activity is forecast to be mainly Unsettled with Active intervals at first on 05 October, then a slight chance of G1/Minor Storm intervals, but then falling to Quiet with Unsettled intervals. Mainly Quiet for much of day 2 (6th Oct), but then the possible low confidence CME arrival could lead to G1/Minor Storms later in the day and through much of 07

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October. The connection to the positive coronal hole high speed stream on 08 October could give further G1/Minor Storms.

**Energetic Particles / Solar Radiation:** The high energy proton flux (greater than 10MeV) is expected to be near background for much of the period, but with a slight chance of rising above the S1 level through the period due to any further M or X-flares, mainly from AR3110, but increasingly from AR3112 as it rotates westward. The high energy electron flux (greater than 2MeV) is expected to follow a rising trend, increasingly becoming persistent at high levels in the absence of significant geomagnetic activity. There is an increasing chance that the electron fluence will reach the Active (1e8 integrated pfu) threshold by the end of the period.

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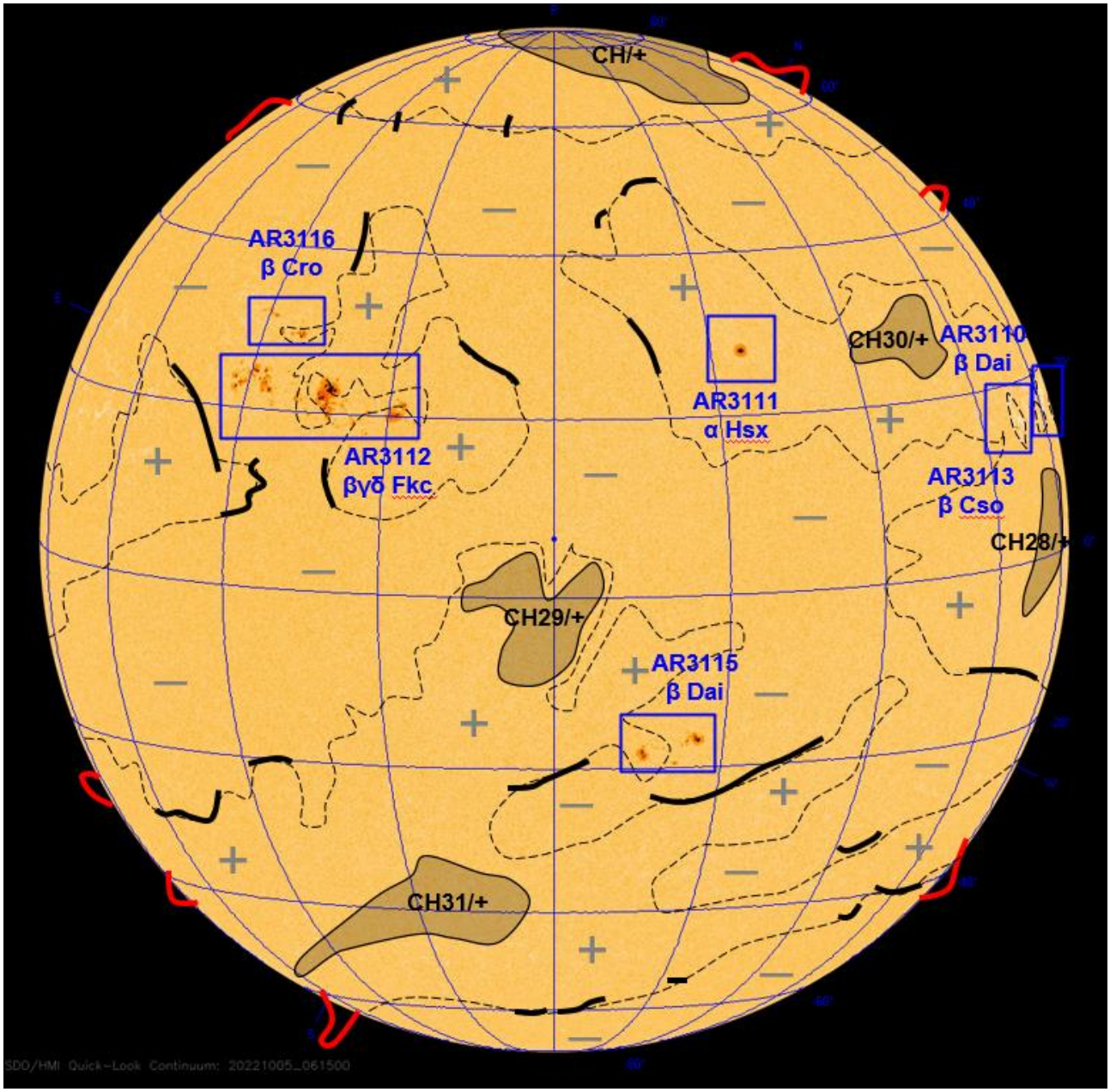
**Figure 1. Solar Analysis Valid 05/0615UTC.**




**Key:** Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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## Geomagnetic Storms:

Two CMEs erupted from the northwest quadrant on 03 October and were assessed as missing the Earth. Prior to these four further CMEs were assessed as having a potentially Earth directed component although with low confidence. There was some evidence of the CMEs being embedded in the high speed stream on 04 October. Two further CMEs left the Sun on 04 October one from the northwest and one from the southeast, near the central meridian. Initial analysis suggests that the second eruption may arrive at Earth, either late on 06 October or early on 07 October, but further analysis will be undertaken as more images become available. A further CME was forecast to glance the Earth on 06 October, but this may now be swept up by the CMEs from 04 October.

A filament eruption, which lifted off the southwest quadrant, early on the 5th Oct is yet to be analysed for any further potential Earth-directed component.

Earth is likely under the influence of a high speed stream from a combination of coronal holes 28 and 30, which are both positioned in a potentially geoeffective location. Any elevated wind speeds from these features are forecast to continue into day 2 (06 October) but this could be affected by any transient CME features. The high speed stream from coronal hole 29 may then connect with Earth on day 4 (08 October), based on an estimated speed of 500km/s.

Geomagnetic activity is forecast to be mainly Unsettled with Active intervals at first on 05 October, then a slight chance of G1/Minor Storm intervals, but then falling to Quiet with Unsettled intervals. Mainly Quiet for much of day 2, but then the possible low confidence CME arrival could lead to G1/Minor Storms later in the day and through much of 07 October. The connection to the positive coronal hole high speed stream on 08 October could give further G1/Minor Storms.

| Geo-Magnetic Storm<br>Probability (Exceedance) | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC)<br>(%) | Day 2 (00-24 UTC)<br>(%) | Day 3 (00-24 UTC)<br>(%) | Day 4 (00-24 UTC)<br>(%) |
|---|---|---|---|---|---|---|
| Minor or Moderate | G1 to G2 | Yes | 10 | 15 | 15 | 20 |
| Strong | G3 | No | 1 | 1 | 1 | 1 |
| Severe | G4 | No | 1 | 1 | 1 | 1 |
| Extreme | G5 | No | 1 | 1 | 1 | 1 |

## Geomagnetic Activity - Earthbound Coronal Mass Ejections

| Date/time 21.5R (UTC) | Halo: Full or Partial | Source | Source Location | Estimated Speed | Estimated Arrival Time | Comments |
|---|---|---|---|---|---|---|
| 04/1734 | Partial | Fliament | SE quadrant | 980km/s | 06/2000 | Currently low confidence |

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**Figure 2: ENLIL shows anticipated arrival time of CME(s). Chance of a CME arriving at Earth late on the 6th Oct or early on the 7th Oct – low confidence.**

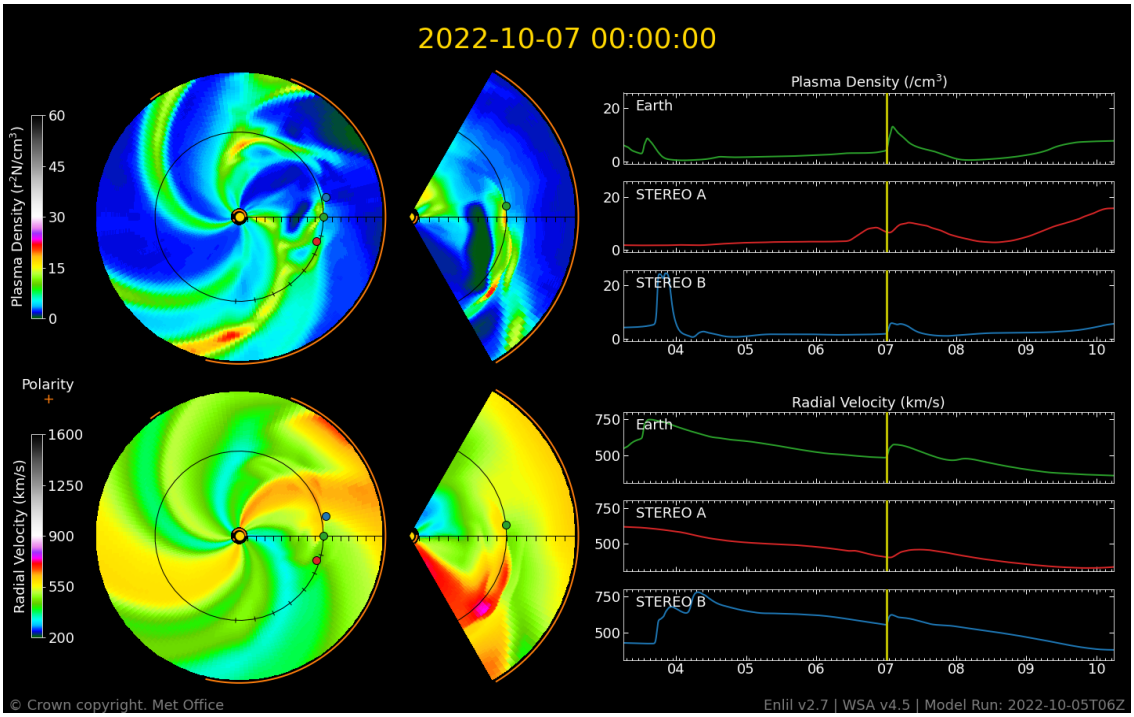


**Figure 3: MOSWOC Enlil Ensemble (below) shows the range of arrival times on the 6th or 7th October.**

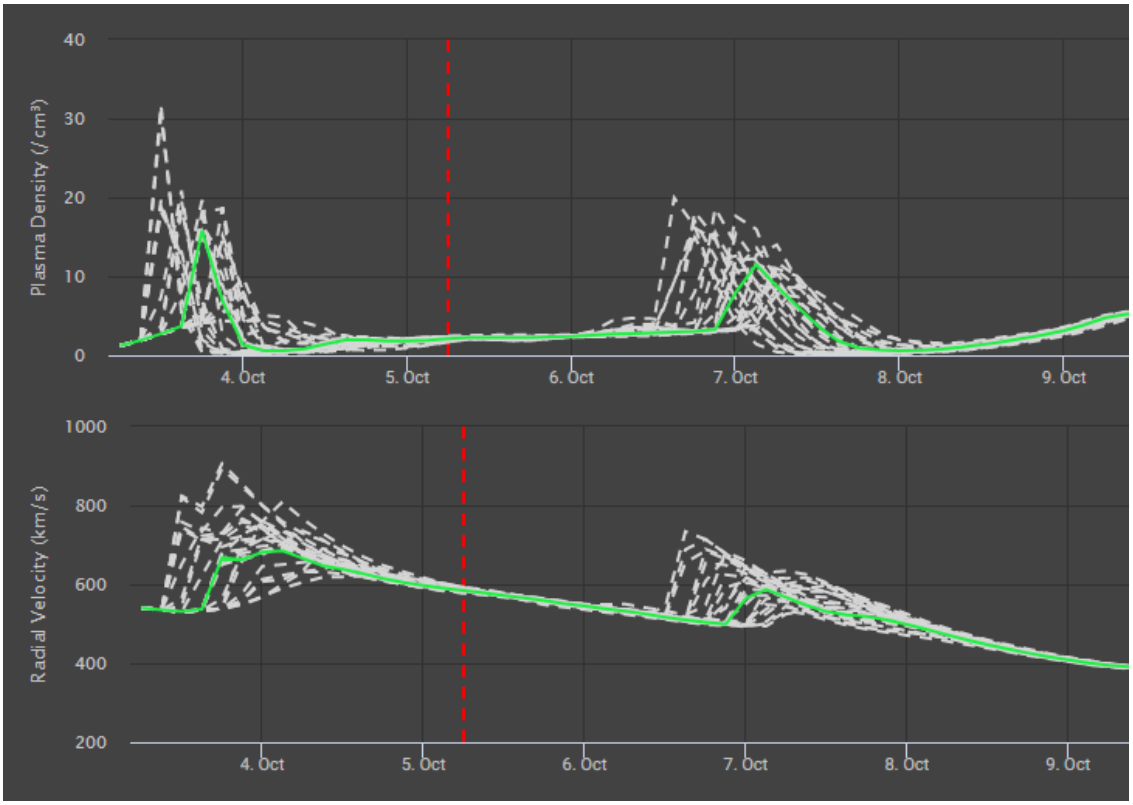


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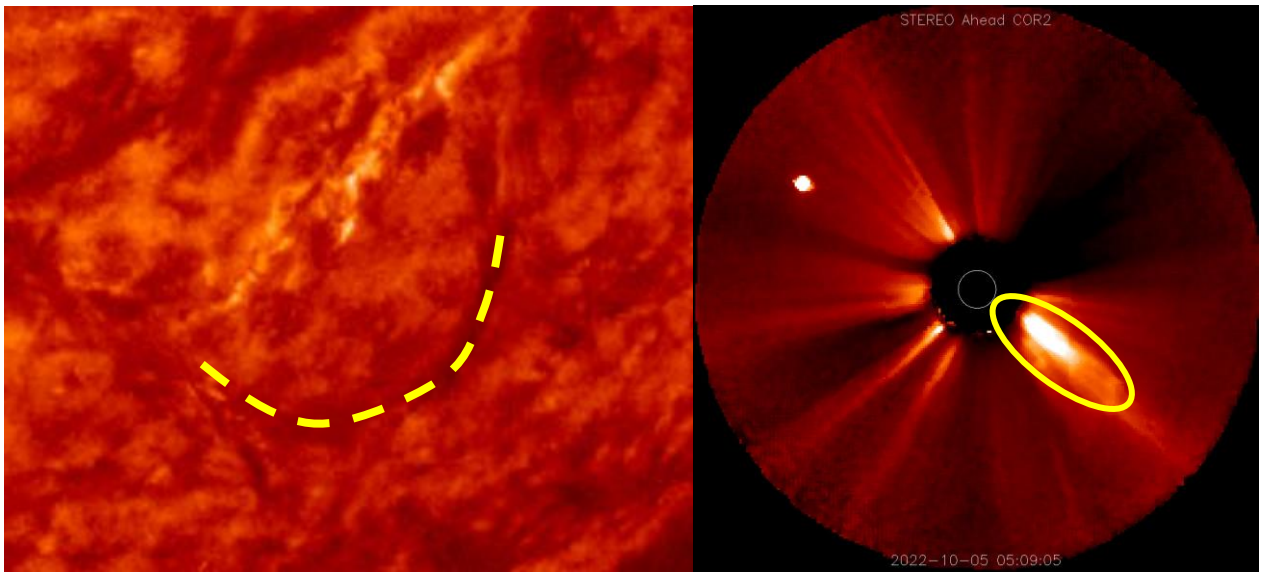
**Figure 4: A filament eruption (yellow dashed line) seen in SDO 304 imagery (left) lifted off the SW quadrant early on the UTC day. This produced a CME, which was observed in STEREO-A (right) and LASCO, although appears to be moving south of the Earth-Sun line – pending analysis for any potential Earth-directed component.**

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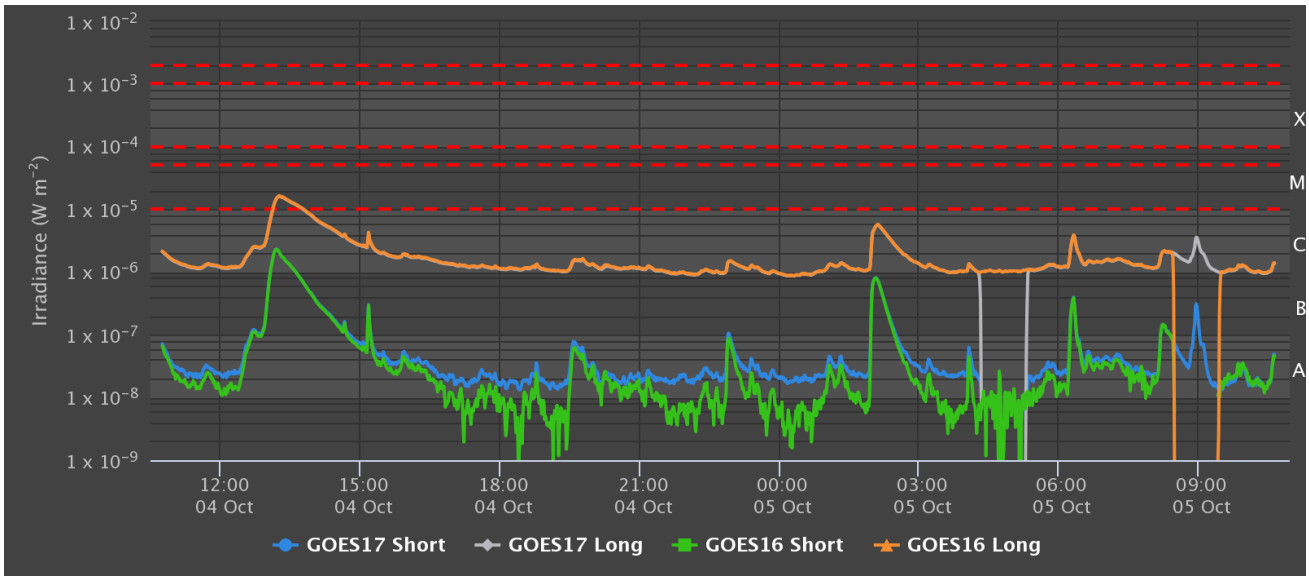
**Radio Blackouts - X-Ray Flares:**
Solar activity is currently Moderate with one M1.6 flare observed from AR3110 in the last 24 hours. AR3110 in the northwest and AR3112 in the northeast present the greatest flare risk, with a likelihood of M-class flares and a chance of X-class flares. The remaining regions, composed of three beta regions and one alpha region appear to be comparatively simple and are only evolving slowly. The risk is expected to decline slightly through the period as AR3110 rotates around the northwest limb.

Solar activity is expected to be mainly Moderate or Low, with a chance of High flare activity from AR3110 and AR3112.

| X Ray Flares | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability | | | (%) | (%) | (%) | (%) |
| Active | R1-R2 M Class | Yes | 70 | 70 | 60 | 60 |
| Very Active | R3 to R5 X Class | No | 20 | 20 | 10 | 10 |

**Figure 5: GOES-16 X-Ray flux**

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## Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) as observed by GOES16 is at background levels. There is a slight chance of exceeding the S1 threshold, primarily from any further M or X-flares from AR3110 (which is rotating around the west limb), but potentially also from AR3112 in the northeast given any sufficiently strong flare event.

| Radiation Storms Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $s^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ S1** | No | 15 | 15 | 10 | 10 |
| **Very Active** | **≥ S3 *** | No | 1 | 1 | 1 | 1 |
| * S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$) | | | | | | |

## High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2MeV) is expected to follow a rising trend through the next four days due to the currently elevated high speed stream. The flux is likely to reach persistently high levels on diurnal maximums as the period progresses, but with a chance of brief dips due to any CME arrivals and associated geomagnetic activity. While these events may temporarily reduce values, especially due to radiation belt displacement, they will also inject additional particles into the belts.

Electron fluence values are likely to follow a rising trend in line with the electron flux values, but with uncertainty introduced due to the possible CME effects.

| GEO Electron Environment Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $day^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ 2 MeV ≥ $1x10^8$** | No | 10 | 30 | 40 | 50 |
| **Very Active** | **≥ 2 MeV ≥ $1x10^9$** | No | 1 | 1 | 1 | 5 |

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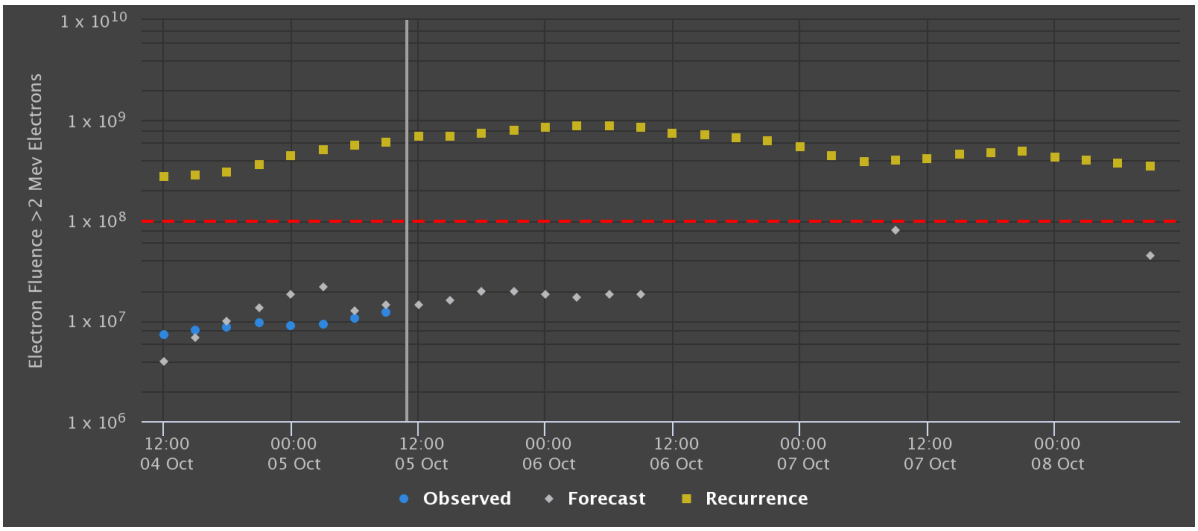
**Figure 5: REFM electron fluence – observations, forecast and recurrence**

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